MEMORANDUM   **CH2M**HILL

Eagle Zinc Company Site — Review of Nature, Extent of Contaminants, and Risk Assessments

TO: Dion Novak

COPIES: John Lowe
              Ryan Loveridge

FROM: Lisa Cundiff

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Introduction

This technical memorandum presents an analysis of the nature and extent of metals in surface soils and residual material stockpiles (residue piles), potential ecological risks, and potential human health risks associated with exposure pathways specifically associated with residue piles at the Eagle Zinc Company Site (the Site). The results presented in this technical memorandum supplement those presented in the Ecological Risk Screening Evaluation (ERA) prepared for the site (ENVIRON, 2004), screening-level human health risk assessment (HHRA) (ENVIRON, 2004), and in the addendum to the remedial investigation (RI) report (ENVIRON, 2005). This technical memorandum evaluates potential exposure pathways associated with future onsite land use scenarios and the potential for transport of contaminants from the residue piles to onsite soils.

Nature and Extent of Inorganics in Residue Piles and Surrounding Surface Soils

Residue Piles

Based on previous investigations (*Remedial Investigation Phase 1 Source Characterization*, Environ, March 2003; *Remedial Investigation Phase 2 Migration Pathway Assessment*, Environ, November 2003; *Remedial Investigation Report*, Environ, March 2005; *and Remedial Investigation Addendum*, Environ, April 2005) a total of 15 residue piles or groups of piles have been identified onsite. Over time, residue from the piles has been distributed across the central, southern, and southwestern portions of the site. Based on boring logs from the Phase 1 RI in the southwestern area (designated as Area 1), residue thickness varies from 0 to 28 feet with an average of 6.5 feet. Residue thickness in the central southernmost portion of the site (designated as Area 2) varies from 0 to 6 feet with an average of 1.6 feet. Residue thickness in the central portion of the site (designated as Area 3) varies from 0 to 9 feet with an average of 2.4 feet. Residue thickness in an area immediately north of the central portion of the site (designated as Area 4) varies from 0 to 6 feet with an average of 1.8 feet. Residue thickness across the manufacturing area (designated as MA) varies from 0 to 5 feet with an average of 1.9 feet. Within the western area (designated as WA), only one out of ten soil borings encountered residue at 1.5 feet thick, no residue was found in the remaining nine borings. Residue was not encountered in any soil borings completed in the northern area of the site. Figure 1 presents the location of the designated areas across the site.

During Phase 1 of the RI, 15 composite samples were obtained from the 15 piles identified onsite and analyzed for toxicity characteristic leaching procedure (TCLP). These composite samples were collected from trenches completed at six locations within each pile/pile group. The trenches extended through the depth of the pile/pile group and samples were collected from the excavator bucket at approximately one-quarter, one-half, and three-quarter depths from the top of each excavation. Three of the composite samples for residue piles failed TCLP levels for lead, RR1-3 (14 milligrams per liter [mg/L]), RR2-11 (6 mg/L) and MP1-21 (83 mg/L). During Phase 2 of the RI, a supplemental sampling effort was completed for the three residue piles identified in the Phase 1 effort as having failed for TCLP levels of lead and were again sampled for TCLP lead levels. Results of the TCLP analyses revealed that all three piles failed for lead.

Residue pile sampling was conducted as part of the RI Addendum, April 2005, and 15 piles/pile groups were sampled at that time and analyzed for target analyte list (TAL) metals. These samples were collected from non-crusted portions of each of the piles/pile groups (0 to 3 inches of outermost portion of the pile) to represent that which would be expected to have the greatest potential for emission of particulates. A direct comparison to Illinois' tiered approach to corrective action objectives (TACO) levels for soil is not appropriate since the residue is not a soil. However, results for zinc ranged from 7,700 milligrams per kilogram (mg/kg) to 210,000 mg/kg, 74 mg/kg to 31,000 mg/kg for lead levels, 6.1 mg/kg to 50 mg/kg for cadmium levels, and 3.1 mg/kg to 200 mg/kg for arsenic levels. In addition to the 15 residue samples collected, one composite sample was collected representing all 15 piles by combining the finest grained fraction from each residue sample (that passing a #200 sieve or < 7 microns) into one sample and analyzed for TAL metals.

Surface Soil

A total of 130 soil borings were completed during the Phase I RI. Soil samples were screened with a photoionization detector (PID) and an X-ray fluorescence (XRF) analyzer at each location. A total of 10 percent of all of the soil samples were submitted for TCL organic compounds and PCBs based on PID screening, and 20 percent of all soil samples were submitted for laboratory analysis of TAL metals based on XRF field screening. A total of 27 soil samples were collected from soil borings during the Phase 1 RI and submitted for laboratory analysis.

Illinois TACO refers to surface soils as the top 1 meter of soil (Section 742, Table B: SSL Parameters). Based on the TACO reference, surface soil samples are herein defined as those soil samples collected between 1 and 3 feet below ground surface (bgs). All soil samples were collected at depths greater than 1 foot bgs due to the presence of residue across the site. The RI Report did not clearly define surface soil samples; however, of the 27 soil samples submitted for laboratory analysis, 20 of the soil samples were collected between 1 and 3 feet of the ground surface and are considered to satisfy the definition of surface soil. During supplemental soil sampling conducted as part of the RI Addendum, four additional surface soil samples each were collected in both the southern portion of the site and along the northern boundary of the site.

The existing surface soil analytical data for the Site indicates that onsite surface soils have been impacted by the residue piles. However, the existing surface soil analytical data does not adequately define the nature and extent of metals contamination in onsite surface soils.

Figure 1 depicts onsite surface soil samples with analytical results above screening levels and residue pile locations. Where available, surface soil analytical results at these locations were compared with the TACO Tier 1 screening level values for arsenic, cadmium, zinc, and the USEPA Region III risk-based concentration (RBC) levels for lead. Comparison of surface soil sampling locations with exceedances of the TACO and USEPA Region III criteria and the locations of residue piles indicates that the following data gaps remain:

- Concentrations of arsenic and lead exceed TACO Tier I and EPA Region III criteria in Area 1 onsite surface soils at A1-3 and A1-26.

- Concentrations of cadmium exceed the TACO Tier I criteria at locations WA-8 and WA-9.

- Concentrations of cadmium exceed TACO Tier I criteria in Area 3 at location A3-25.

- Concentrations of arsenic exceed TACO Tier I criteria at location A4-15.

- Concentrations of zinc were detected just above the TACO Tier I criteria at location NA-S2 in the sample duplicate, but not in the sample itself.

Based on the lack of surface soil data and the exceedances evident in the data that exist, additional sampling is recommended to define the extent of contamination in surface soil at these locations. Locations of the exceedances indicate that the surface soils near and down wind from the residue piles have been impacted.

Review of Ecological Risk Assessment

The approach for the detailed review of the ecological risk assessment was to first evaluate existing soil data, define a reasonable future risk scenario, and then evaluate risks associated with the reasonable future risk scenario.

Evaluation of the Soil Data

A preliminary review (i.e., a comparison of maximum concentrations) of the March 2005 surface soil data indicated that the actual concentrations may be significantly different than the surface soil concentrations evaluated in the RI and RI Addendum Ecological Risk Screening Evaluation (ERSE). Therefore, the surface soil dataset used in the RI was compared to an updated dataset that included the RI dataset as well as the surface soil data collected in March 2005. For samples with duplicates, the maximum concentration of either the duplicate or parent sample was used in the analyses. One-half the reporting limit was used for all sample concentrations that were below the reporting limit. Sample A1-3-S1-2 was used in the analyses rather than A1-3-S1 because this sample contained less residue material. Statistical comparisons were performed using means-test (parametric or nonparametric). Determination of whether to use a parametric or nonparametric test was done by checking for normality (Shapiro-Wilks) and homogeneity of variance (F-value). If both datasets were normal and had homogenous variances, then a parametric test (simple t-test) was performed. Otherwise, a non-parametric Mann-Whitney test was performed. Data were log transformed to achieve normality, if possible. The results of the analyses are presented in Table 1. There were no significant differences between the old (RI) and new (RI dataset plus March 2005 data) for any of the metals evaluated, despite higher maximum concentrations in the March 2005 data for some of the metals. For this reason, no further

analyses were necessary. The ecological risks to terrestrial receptors are therefore considered negligible under current conditions, as was presented in the RI.
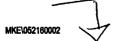
Future Risk Scenario

A remediation action that involves disturbance of the residue piles may disperse large amounts of small residue particles into areas of natural or created vegetation or the waterways. The ecological risk associated with this scenario was evaluated with a conservative approach that followed the RI protocol and used the concentrations from the residue composite sample. The residue composite sample was the most fine-grained fraction (the fraction that passed through a #200 sieve or <75 microns) combined from each residue sample.

Table 2 presents the results of the Steps 1, 2, and 3 terrestrial wildlife extended removal site evaluation (ERSE) using the composite sample concentrations in place of surface soil concentrations. All other parameters and assumptions (e.g., ecotoxicity screening values, food ingestion rates, etc.) are the same as those used in the RI and were not presented for this review. The Maximum Scenario is that based on exposure assumptions presented in Steps 1 and 2 of the RI. The Refined Scenario is that based on exposure assumptions in Step 3. The results of these analyses indicate that there is high risk from the zinc concentrations in the composite sample to all terrestrial wildlife. A high risk to American robins from lead may also be present, but was not determined because a less conservative avian ecotoxicity screening value was not available for the RI. If a factor of 10 between the no observed adverse effect level (NOAEL) and lowest observed adverse effects level (LOAEL) is assumed, the risk to American robins from lead in the composite sample is considered high. Low to moderate risk is also associated with lead and selenium to the deer mouse.

Table 3 presents the results of Steps 1 and 2 sediment ERSE using the composite sample concentrations in place of sediment concentrations. This scenario is intended to evaluate the possibility of fine-grained residue particles entering the drainage ways, resulting in exposure to sediment-associated ecological receptors. Cadmium, cobalt, copper, lead, nickel, silver, and zinc had hazard quotients (HQs) greater than 10 when based on the RI selected screening value and therefore, are associated with high risk to sediment-associated receptors. The remaining metals, except for chromium, also exceeded their respective ecotoxicity sediment screening values, and therefore, are also associated with a low to moderate level of risk.

Table 4 presents the results of a comparison of estimated surface water concentrations to surface water ecotoxicity screening values. Approximate surface water concentrations were estimated by multiplying the average surface water concentration (on- and offsite, both drainage ways) by the ratio of the fine-grained composite fraction concentration to the average sediment concentration (on- and offsite, both drainage ways). Aluminum, cadmium, copper, iron, nickel, and zinc had HQs greater than 10 for one or more receptors when using the RI-selected screening value, and therefore, are associated with high risk to surface water-associated receptors. Arsenic and manganese also exceeded screening values for the RI-selected screening value, and therefore, are also associated with a low to moderate level of risk. It should be noted that the impacts to aquatic habitat are dependent on the quality of the habitat available in the future condition of the site. Although high concentrations of metals in surface water and sediment are currently present in the drainage ways, poor habitat quality limits ecological exposure. Future scenarios with poor habitat

quality will also limit ecological exposure despite elevated surface water and sediment concentrations. Future scenarios with habitat improvement will increase ecological exposure, and therefore, increase ecological risk.

Several assumptions, including those already discussed in the RI, were included in the analysis and include the following:

- The concentrations in each of the residue piles portions were assumed to be the same as those in the composite sample. The concentration in each pile was not known. The sample is most likely not homogenous, and several residue piles most likely have fine-grained particle concentrations that are above and below the average concentration used in the analyses.

- The volume of fine-grained particles that can be released from all residue piles is sufficient to cover the site. The volume of particles is not known. The area of the site (152 acres) was used in the Step 3a refined scenario to modify the exposure scenario relative to the home range of the ecological receptors. The impact to ecological receptors from coverage of an area smaller than 152 acres with fine-grained particles was not determined.

- The concentrations in the residue particles are 100 percent bioavailable to ecological receptors. The composite sample fraction was selected for these analyses because it was considered the most bioavailable of the residue size fractions sampled.

These assumptions can be refined by determining the concentration and the volume of fine-grained particles in each pile. These additional refinements may result in one of several conclusions including negligible site-wide risk, localized areas presenting unacceptable risk (i.e., "hotspots" are associated with individual piles), or unacceptable site-wide risks associated with pile disturbances that result in dispersion of particles.

The results of these analyses indicate that there is high risk to ecological receptors from fine-grained particles dispersed to areas of natural or created vegetation or the waterways. Future remedial actions with the residue piles require approval and monitoring to prevent ecological receptor contact with fine-grained particles.

Supplemental Human Health Risk Assessment Calculations Summary

Supplemental risk assessment calculations conducted for onsite conditions at the Site indicate that concentrations of lead and zinc in the residue piles may be associated with exposures and risks that are higher than U.S. Environmental Protection Agency (USEPA) risk reduction objectives (USEPA, 1994 and 1991). These risks were based on evaluations of potential current land uses (potential trespassers to the site) and hypothetical future land uses (potential construction worker exposures, industrial land use, or residential land use). These potential exposure pathways could be present should the residue piles be graded and left onsite as part of future development of the site, or if the residue piles are excavated and removed from the site for use as fill elsewhere. Risks higher than risk reduction objectives generally are not associated with concentrations of metals detected in the surrounding soils, based on data characterizing current conditions. However, there is the potential for continuing releases from the residue piles, which might result in changes in concentrations of metals in the future. Potential transport mechanisms from the piles include emissions of

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wind-blown dust and surface runoff following precipitation. The results from these calculations suggests that surface runoff is potentially the more significant transport mechanism, though emissions of windblown dust could increase over currently calculated levels should the piles be disturbed or excavated in the future.

Summary of Onsite Analytical Results

Analytical results in pile residue samples and surrounding onsite soil samples have been reported in the addendum to the RI report (ENVIRON, 2005). In addition, residue and soil samples were collected in April 2005 by the Illinois Environmental Protection Agency (IEPA). Analytical results from the residue and soil samples, as presented in the RI addendum, are shown in Tables 5 and 6. The locations of these samples are shown in Figure III-1 in the RI addendum report. Analytical results from the residue and soil samples collected by IEPA are shown in Tables 7 and 8. A figure depicting the locations of the IEPA analytical results is included as Attachment 1.

Evaluation of Onsite Risks Under Hypothetical Future Residential Land Use

Evaluation of risks potentially associated with soils and residues onsite based on a residential land use scenario assumes that 1) the site could be developed for residential use in the future; or 2) residues from the site could be excavated and reused as fill at locations where residents could be located. Each residue pile was treated as an individual exposure unit for purposes of this evaluation, which involved comparison of concentrations in each pile with residential Preliminary Remediation Goals (PRGs) developed by USEPA Region 9 (USEPA, 2004). This comparison is presented in Table 9. Onsite soil samples were also screened against PRGs to identify chemicals of potential concern (COPCs) based on a residential land use scenario. This comparison is presented in Table 10.

Concentrations in onsite soils generally fell below their respective residential PRG concentrations. Concentrations in soil less than PRGs pose risks smaller than 1×10^{-6} or noncancerous hazard quotients smaller than one; in the case of lead, concentrations higher than the PRG indicate the potential for blood lead levels to be elevated above an action level of 10 migrogram(s) per deciliter ($\mu g/dL$). While arsenic concentrations were higher than their PRG, those concentrations were consistent with background levels in soil. Concentrations of iron and lead in onsite soil were higher than PRGs in two soil samples, A1-3-S1 and A1-26-S1, both located in Area 1 in the southern portion of the site. These samples were collected next to piles RR1-1 and RR1-2. Lead concentrations in particular were elevated above background level concentrations. While this does not represent a full characterization of potential risks in this area, the soil sampling results provide an indication of potentially elevated risks and potential releases of metals from the adjacent residue piles.

COPCs in residue piles were iron, lead, and zinc; these metals were detected at concentrations above their PRGs in most of the residue piles. Concentrations of other metals (arsenic, antimony, cadmium, copper, and manganese) were elevated above PRGs in a few piles. Based on the results of this evaluation, concentrations of zinc in most piles would exceed an HQ of one. Concentrations of lead in most piles would be associated with a blood lead level greater than 10 $\mu g/dL$ in children.

Evaluation of Onsite Risks Under Hypothetical Future Industrial Land Use

As described previously, each residue pile was treated as an individual exposure unit for purposes of this evaluation, which involved comparison of concentrations in each pile with industrial PRGs developed by USEPA Region 9 (USEPA 2004). This comparison is presented in Table 11. Onsite soil samples were also screened against PRGs to identify COPCs based on a residential land use scenario. This comparison is presented in Table 12.

Based on this evaluation, onsite soils contained concentrations lower than PRGs, with the exception of one location in Area 1 (Sample A1-3-S1). Concentrations of lead and zinc were higher than industrial PRGs in most piles. Based on the results of this evaluation, concentrations of zinc in most piles would exceed an HQ of one, under a future industrial land use scenario. Concentrations of lead in most piles would be associated with elevated blood lead levels in sensitive receptors, in this case, women of childbearing age.

Evaluation of Onsite Risks—Other Land Uses

Other land uses considered in this evaluation include construction workers and recreational land uses (i.e., trespassers). Construction workers potentially could be exposed to concentrations in the residue piles should they be excavated or disturbed in the future. Observations of the site by IEPA have noted that the residue piles are potentially accessible to trespassers who could use the piles for recreational purposes (i.e., driving all-terrain vehicles [ATVs]).

Potential exposures to construction workers were evaluated using PRGs calculated with default exposure factors published by the Oak Ridge National Laboratory (ORNL) Risk Assessment Information System (RAIS) (http://risk.lsd.ornl.gov/prg/equations/exc_sol_nrad_tot.shtml). Based on the previous screening using industrial PRGs, this evaluation focused on lead concentrations in the residue piles. A PRG for exposure levels for lead to construction workers was calculated using USEPA's Adult Lead Model (http://www.epa.gov/superfund/programs/lead/products/alm05_03.xls). An example calculation is presented in Attachment 2.

Comparison of lead concentrations in pile residue with the construction PRG is presented in Table 13. Lead concentrations were higher than the PRG in four piles: MP1-21, RCO-10, RR1-3, and RR2-11. In addition, emissions to the air during construction were estimated using the default heavy construction emission factor of 1.2 ton/acre per month, described in AP-42 (USEPA, 1995). Concentrations in air were modeled as square source areas using SCREEN3. The source areas represented by the volume of residues in the piles were estimated assuming each had been graded and spread to a uniform depth of 6 inches. Sample calculations for piles MP1-21 and RR2-11 are shown in Attachment 3.

The results of this air pathway analysis indicate that 8-hour average concentrations of lead in air associated with construction emissions could exceed the Occupational Safety and Health Administration (OSHA) action level of 30 micrograms per cubic meter ($\mu g/m^3$) for piles MP1-21 and RR2-11. Exceeding the action level triggers additional monitoring requirements under OSHA's lead standard (40 CFR 1910.1025). In addition, lead concentrations in air at pile MP1-21 could exceed the Permissible Exposure Limit (PEL) of 50 $\mu g/m^3$. When concentrations exceed the PEL levels, air and biological monitoring for

lead exposure are performed, personal protective equipment and engineering controls used, and worker training provided.

Potential exposures of trespasser/recreational users of the site were evaluated for lead in pile residues. A PRG for lead for recreational uses was estimated using the Adult Lead Model, with exposure factors presented in the ORNL RAIS (http://risk.lsd.ornl.gov/prg/equations/rec_sol_nrad_tot.shtml). An example calculation is presented in Attachment 2. Concentrations of lead in pile residues were higher than the recreational PRG in piles MP1-21, NP-15, RCO-10, RR1-3, and RR2-11. Concentrations of lead in these piles would be associated with elevated blood lead levels in sensitive receptors, in this case, women of childbearing age.

Updated Air Pathway Analysis

The RI addendum addressed potential long-term concentrations of metals in air under current site conditions. Current site conditions for this analysis are defined as containing weathered piles with aggregate material surfaces characterized by finite availability of erodible material and crusting of the surface that binds erodible material and reduces erosion potential. The results of that analysis indicated that emissions of metals in dust from the piles would not elevate concentrations in on- or offsite soils, and would not be associated with risks higher than USEPA risk reduction objectives.

A supplemental analysis was conducted based on the assumption that the piles could be disturbed in the future through construction or excavation. Under this assumption, concentrations in air from emissions from pile residue were modeled as square source areas using SCREEN3. The source areas represented by the volume of residues in the piles were estimated assuming each had been graded and spread to a uniform depth of 6 inches (see Attachment 3 for the source area assumptions). Emissions were assumed that the piles represented an "unlimited" reservoir of highly erodible soil. Windblown dust is assumed to be suspended into the air only at times when the wind speed is higher than a threshold friction velocity. For highly erodible soils (unlimited potential), annual dust emissions are proportional to the distribution of wind speeds above the threshold friction velocity. The threshold friction velocity is considered to be proportional to the typical particle size of the surface soil. This emission factor model has been developed by EPA for the rapid assessment of particulate emissions from surface contamination sites (EPA, 1985) and is also used in EPA's Soil Screening Guidance to evaluate the inhalation exposure pathway for non-volatile contaminants (EPA, 1996). The default assumptions presented in Appendix D to the Technical Background Document of the Soil Screening Guidance were used to estimate emissions to the air. Concentrations in soil associated with deposition of particulates onto the ground were estimated using the methodology developed in USEPA's combustion risk assessment guidance (USEPA, 1998). The specific assumptions used to model concentrations in soil are presented in the RI Addendum (ENVIRON, 2005).

The results of the air pathway analysis for future conditions indicated that emissions from the piles after they had been disturbed would result in slightly elevated concentrations in surrounding soils. However, available soil sampling data (Tables 6 and 8) indicate that onsite concentrations of metals in soil are considerably higher than would be indicated by emissions of dust followed by deposition onto the surrounding soils. Therefore, the results of this analysis suggest that some transport mechanism other than wind blown dust

transport is responsible for concentrations of metals elevated above background levels that are detected in soils surrounding the residue piles. Further discussion of potential transport mechanisms is presented in the following section.

Potential Runoff from Residue Piles

Another possible mechanism for release of soils and metals from the residue piles is surface runoff resulting from precipitation. Soil losses from rainfall and runoff were estimated using the Universal Soil Loss Equation (USLE). The USLE was developed by statistical analyses of many plot years of rainfall, runoff, and sediment loss data from many small plots located around the country (Wischmeier and Smith, 1978).

The Universal Soil Loss Equation is as follows:

$$A = RKLSCP$$

where:

A = Average annual soil loss in tons per acre per year

R = Rainfall and runoff erosivity index for a given location

K = Soil erodibility factor

L = Slope length factor

S = Slope steepness factor

C = Cover and management factor

P = Conservation or support practice factor

The USLE calculations are shown in Table 15. These results indicate that annual losses of soil could run off from the piles and become deposited onto the surrounding soils. This runoff could be the mechanism underlying elevated concentrations of metals in surface soil surrounding the piles. For example, the surface soil samples to the north of the piles (NA-S1 through S4 detected zinc at concentrations of 950 to 7,700 mg/kg. These concentrations are well above background zinc levels (typically, background levels for zinc in soil are approximately 400 mg/kg). Concentrations of zinc in the northern residue piles (RRO-12 and NP-16) are 120,000 to 180,000 mg/kg (Table 5). These results in surrounding soils and the piles, combined with the runoff calculations, suggest that some releases from the residue piles to the surrounding soils have occurred.

Elevated concentrations of lead (500 and 1,100 mg/kg) and zinc (2,700J and 4,800J) have been detected in surface soil samples to the south of piles RR1-1, RR1-2, and RR1-3 and west of pile MP1-21 (surface soil samples A1-3-S1 and A1-26-S1). Lead concentrations of 31,000 mg/kg have been detected in pile MP1-21. Zinc concentrations are elevated in all of these piles (ranging from 7,700 to 190,000 mg/kg). Again, these results suggest that runoff may be a plausible mechanism for the elevated concentrations in surface soil surrounding the piles.

Conclusions

The results from these supplemental risk assessment calculations are as follows:

- Concentrations of lead and zinc in the residue piles are associated with risks higher than USEPA risk reduction objectives when evaluated using residential land use assumptions. Concentrations of lead in residues are higher than the residential PRG, meaning that potential lead exposures under future residential use could be associated with blood lead levels in children higher than the 10 µg/dL threshold blood lead level (USEPA, 1994). Concentrations of zinc are higher than the residential PRG, meaning that potential zinc exposures under future residential use could be higher than a noncancerous HQ of one (USEPA, 1991). These results are applicable across all of the piles.

- Concentrations of metals in surrounding soils generally do not exceed PRGs, with the exception of lead and zinc in limited areas in the southern portion of the site. With the exception of these areas to the south, concentrations in surface soil, under current conditions, do not exceed risk reduction objectives. However, as discussed below, there are transport mechanisms from the piles that could result in continuing releases to surrounding soils.

- Concentrations of lead and zinc in most of the residue piles are higher than industrial PRGs, indicating that potential exposures to these concentrations could be higher than risk reduction objectives (USEPA, 1991 and 1994). Concentrations of lead in residues are higher than the industrial PRG, meaning that potential lead exposures of women of child-bearing age under future industrial use could be associated with blood lead levels in children higher than the 10 µg/dL threshold blood lead level (USEPA, 1994). Concentrations of zinc are higher than the residential PRG, meaning that potential zinc exposures under future industrial use could be higher than a noncancerous HQ of one (USEPA, 1991). Concentrations in surrounding surface soil, under current conditions, generally do not exceed risk reduction objectives. However, as discussed below, there are transport mechanisms from the piles that could result in continuing releases to surrounding soils.

- Concentrations of lead in most of the residue piles are higher than PRGs based on construction worker and trespasser (recreational user) exposure scenarios. This means potential lead exposures of women of child-bearing age under these land uses could be associated with blood lead levels in children higher than the 10 µg/dL threshold blood lead level (USEPA, 1994). Potential exposures of construction workers to lead during excavation or construction activities could be higher than the action level or PEL for piles MP1-21 or RR2-11.

- Under current conditions, emissions of dust from the piles do not appear to produce significant concentrations in air or deposition of metals onto surrounding soils. Under future conditions, should the piles be disturbed, graded, or excavated, potential dust emissions could increase. However, the resulting concentrations under these future conditions do not appear to result in deposition that would significantly elevate concentrations in onsite soils. In particular, analytical results from onsite soils suggest that some mechanism other than emissions of dust from the piles is the cause for elevated concentrations in soils surrounding the piles.

- Evaluation of potential runoff from the residue piles, due to precipitation, represents a potential transport mechanism of metals to surrounding soils. Elevated concentrations of lead and zinc (above background levels) are found in soils surrounding the residue piles.

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Tables

TABLE 1
Comparison of RI Surface Soil Dataset Concentrations to RI + March 2005 Surface Soil Dataset Concentrations
Eagle Zinc Company Site.

COC	Type	Shapiro-Wilks Test for Normality [a]				Equality of Variance [b,c]			Background Comparison [b,c,d]			
		Untransformed Data Normal?	p-value	Log-transformed Data Normal?	p-value	Equal Variance?	F Value	p-value	Mann-Whitney Statistic	p-value	t Value	p-value
Aluminum	RI Dataset			No	0.05	Yes	1.2	0.85			-1.15	0.25
	RI and March 2005 Dataset			No	0.03							
Antimony	RI Dataset			Yes	0.28				344	0.14		
	RI and March 2005 Dataset			No	0.00							
Arsenic	RI Dataset	No	0.04			Yes	1.0	0.94			-0.20	0.84
	RI and March 2005 Dataset	No	0.01									
Barium	RI Dataset	No.	0.00			Yes	1.2	0.57			0.16	0.87
	RI and March 2005 Dataset	No	0.00									
Beryllium	RI Dataset	No	0.00			Yes	1.4	0.44			-1.26	0.21
	RI and March 2005 Dataset	No	0.00									
Calcium	RI Dataset			No	0.00				438	0.95		
	RI and March 2005 Dataset			No	0.00							
Cadmium	RI Dataset	No	0.00			Yes	1.3	0.52			-0.15	0.88
	RI and March 2005 Dataset	No	0.00									
Chromium	RI Dataset			No	0.03	Yes	1.2	0.57			-1.26	0.21
	RI and March 2005 Dataset			No	0.05							
Cobalt	RI Dataset	No	0.00			Yes	1.1	0.89			0.11	0.91
	RI and March 2005 Dataset	No	0.00									
Copper	RI Dataset			Yes	0.37				419	0.73		
	RI and March 2005 Dataset			No	0.00							
Iron	RI Dataset	Yes	0.15			Yes	1.3	0.52			-0.98	0.33
	RI and March 2005 Dataset	Yes	0.07									
Lead	RI Dataset			No	0.01				351	0.17		
	RI and March 2005 Dataset			No	0.00							
Magnesium	RI Dataset			No	0.00				356	0.21		
	RI and March 2005 Dataset			No	0.01							
Manganese	RI Dataset	No	0.00			Yes	1.1	0.77			0.38	0.70
	RI and March 2005 Dataset	No	0.00									
Mercury	RI Dataset			No	0.01				420	0.74		
	RI and March 2005 Dataset			No	0.00							
Nickel	RI Dataset			No	0.00				407	0.80		
	RI and March 2005 Dataset			No	0.02							
Potassium	RI Dataset			Yes	0.15	Yes	1.3	0.51			-1.4	0.17
	RI and March 2005 Dataset			Yes	0.09							
Selenium	RI Dataset			No	0.00				394	0.47		
	RI and March 2005 Dataset			No	0.00							
Silver	RI Dataset			No	0.00				420	0.74		
	RI and March 2005 Dataset			No	0.00							
Sodium	RI Dataset	No	0.00			Yes	1.2	0.62			-0.40	0.69
	RI and March 2005 Dataset	No	0.00									
Thallium	RI Dataset			Yes	0.31	No	2.3	0.03	339	0.12		
	RI and March 2005 Dataset			Yes	0.09							
Vanadium	RI Dataset			Yes	0.10	Yes	1.0	0.93			-1.0	0.33
	RI and March 2005 Dataset			Yes	0.39							
Zinc	RI Dataset	No	0.00			Yes	1.0	0.95			-0.01	0.99
	RI and March 2005 Dataset	No	0.00									

Notes:
Non-detects were included at 1/2 the detection limit

▓▓▓▓ = Test not performed

▓▓▓▓ = Data (untransformed or transformed) used for comparison; data with closest approximation to normal distribution and greatest equality of variance (based on p-values) selected; Untransformed data used for non-parametric tests.

[a] p-values were considered significant at $p \leq 0.05$

[b] An equality of variance test was performed only if both data sets had normal distributions

[c] A t-test comparison was made only if both data sets were normal and had equal variances, otherwise a non-parametric Mann-Whitney rank-sum test was performed

[d] On-site Concentrations are not significantly different from background concentrations

TABLE 2
Terrestrial Receptor Hazard Quotients Based on Concentrations in the Fine-grained Residue Composite Sample
Eagle Zinc Company Site

Chemical	Deer Mouse				American Robin				Red-tailed Hawk			
	Maximum Scenario		Refined Scenario		Maximum Scenario		Refined Scenario		Maximum Scenario		Refined Scenario [a]	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Arsenic	139	15	1.2	0.13	3.8	1.3	0.26	—	0.03	—	—	—
Cadmium	121	13	6.0	0.66	150	11	5.4	0.39	8.1	0.59	—	—
Chromium	0.01	NA	—	NA	39	7.9	1.2	0.24	1.3	0.27	—	—
Copper	61	51	0.36	—	32	24	0.92	—	7.7	5.9	0.02	—
Lead	207	22	10	1.1	739	NA	46	NA	48	NA	0.29	—
Mercury	0.99		—		4.9	2.4	0.12	—	0.08	0.04	—	—
Nickel	29	16	1.4	0.76	25	18	0.24	—	1.4	1.0	0.01	—
Selenium	17	11	2.3	1.5	6.0	3.0	0.18	—	1.4	0.72	—	—
Silver	0.58	—	—	—	0.97	—	—	—	0.26	0.11	—	—
Zinc	1,970	1,072	130	71	39,355	4,356	2,026	224	2,747	304	14	1.6

Note: The Maximum Scenario was evaluated in Steps 1 and 2 of the RI. The Refined Scenario was evaluated in Step 3a.

— = Calculation not performed because HQ < 1 using more conservative calculation parameters

[a] The SFF (0.57) used in the RI HQ calculation for the red-tailed hawk Refined Scenario was replaced a corrected value (0.23)

TABLE 3
Sediment Hazard Quotients Based on Concentrations in the Fine-grained Residue Composite Sample
Eagle Zinc Company Site

Chemical	Composite Sample Concentration (mg/kg)	Region V	Region V	NOAA TEL	NOAA PEL	NOAA UET	USGS PEL	USGS SEL	USGS TET	USGS ERM	USGS PEC	OMOE SEL	OMOE LEL
						Sediment Hazard Quotients							
Aluminum	12,000	–	–	–	–	–	–	–	–	–	–	–	–
Antimony	Rejected	–	–	–	–	–	–	–	–(	–	–	–	–
Arsenic	55	▓	5.6	9.3	3.24	0.32	3.24	1.7	3.2	0.65	1.7	1.7	9.2
Barium	220	–	–	–	–	–	–	–	–	–	–	–	–
Beryllium	1.1	–	–	–	–	–	–	–	–	–	–	–	–
Cadmium	22	▓	22	0.04	6.2	7.3	6.2	2.2	7.3	2.4	4.4	2.2	37
Calcium	5,600	–	–	–	–	–	–	–	–	–	–	–	–
Chromium	50	▓	1.2	1.3	0.56	0.53	0.56	0.45	0.50	0.34	0.45	0.45	1.9
Cobalt	630	–	▓	–	–	–	–	–	–	–	–	–	–
Copper	3,700	▓	117	104	19	43	19	34	43	9.5	25	34	231
Iron	82,000	–	–	–	–	–	–	–	–	–	–	▓	4.1
Lead	7,100	▓	198	192	78	56	78	28	42	65	55	28	229
Magnesium	3,200	–	–	–	–	–	–	–	–	–	–	–	–
Manganese	2,500	–	–	–	–	–	–	–	–	–	–	▓	5.4
Mercury	0.43	▓	2.5	2.5	0.88	0.77	0.88	0.22	0.43	0.33	0.41	0.22	2.2
Nickel	1,600	▓	70	89	45	37	44	21	26	32	33	21	100
Potassium	660	–	–	–	–	–	–	–	–	–	–	–	–
Selenium	15	–	–	–	–	–	–	–	–	–	–	–	–
Silver	58	▓	116	–	–	–	–	–	–	–	–	–	–
Sodium	1,600	–	–	–	–	–	–	–	–	–	–	–	–
Vanadium	34	–	–	–	–	–	–	–	–	–	–	–	–
Zinc	180,000	▓	1,488	1,462	571	346	571	220	333	667	392	220	1,500

Notes:

▓ = Hazard Quotient based on Screening Value used in the RI

TABLE 4

Surface Water Hazard Quotients Based on Concentrations in the Fine-grained Residue Composite Sample
Eagle Zinc Company Site

Chemical	Estimated Surface Water Concentration (mg/L) [1]	Hazard Quotient		
		Water Quality	Great Blue Heron	Mink
Aluminum	0.57	0.77	0.21	23
Arsenic	0.032	0.17	0.019	1.4
Barium	0.19	0.039		
Cadmium	0.0086	4.3	8.6	19.7
Chromium	0.0056	0.51		
Copper	0.26	12	0.28	0.89
Iron	15	15		
Lead	0.043	0.85	0.30	0.044
Manganese	2.2	2.2		
Mercury	0.00014	0.14		
Nickel	1.3	144	0.32	0.64
Silver	0.11	0.023		
Zinc	179	4,404	2,103	192

Notes:

[1] Surface water concentrations estimated by multiplying the average surface water concentration (on- and off-site, both drainageways) by the ratio of the fine-grained composite fraction concentration to the average sediment concentration (on- and off-site, both drainageways).

TABLE 5

Concentrations Detected In Pile Residues

Eagle Zinc Company Site, Hillsboro, Illinois

Sample ID	Composite Sample	CPH-6	CPH-9	MP1-21	NP-13	NP-14	NP-15	NP-16	RCO-10	RCO-5	RRO-12D	RRO-12	RR1-1	RR1-2	RR1-3	RR1-4	RR2-11
Parameter (mg/kg)																	
Aluminium	12,000	7,000 J	3,800 J	5,700	8,300 J	3,900 J	9,600 J	6,000 J	20,000 J	8,300 J	11,000	7,700 J	5,300	7,300	4,500 J	8,000 J	35,000 J
Antimony	R	8.30	16.00 U	190.00 J	17.00 U	16.00 U	110.00	3.80 J	190.00	6.50	17.00 UJ	41.00	16.00 UJ	16.00 UJ	16.00 U	16.00 U	400.00
Arsenic	55.00	33.00 J	8.10 J	200.00	5.70 J	3.10 J	11.00 J	12.00 J	41.00 J	19.00 J	15.00	11.00 J	9.10	6.80	16.00 J	7.90 J	21.00 J
Barium	220	210	150	870	290	210	110	130	350	230	420	170	160	130	480	150	130
Beryllium	1.10 J	1.30	0.68	0.84	1.20	0.66	0.97	0.86	2.40	2.90	2.00	1.60	1.10	0.79	0.86	0.89	1.50
Cadmium	22.00	10.00 U	6.10 U	50.00	23.00 U	32.00 U	19.00 U	15.00 U	24.00 U	21.00 U	10.00	6.90 U	5.60	9.40	35.00 U	4.90 U	7.20 U
Calcium	5,600	9,900 J	7,500 J	2,100	5,000 J	1,900 J	8,200 J	16,000 J	20,000 J	17,000 J	19,000	17,000 J	6,200	3,500	950 J	9,400 J	3,300 J
Chromium	50.00	10.00	4.40	22.00 J	11.00	4.90	62.00	22.00	220.00	30.00	38.00 J	47.00	8.60 J	9.20 J	12.00	6.80	290.00
Cobalt	630.00	250.00	440.00	110.00	8.20	4.40	500.00	430.00	760.00	570.00	560.00	440.00	140.00	70.00	9.70	880.00	93.00
Copper	3,700	2,400 J	2,100 J	3,600	190 J	140 J	1,900 J	1,900 J	24,000 J	2,200 J	3,400	2,200 J	3,400	2,000	400 J	2,600 J	34,000 J
Iron	82,000	110,000	47,000	110,000	24,000	5,500	31,000	36,000	80,000	25,000	73,000	48,000	75,000	60,000	86,000	72,000	77,000
Lead	7,100	800	79	31,000	76	74	1,200	550	2,500	530	520	810	450	250	1,800	120	7,700
Magnesium	3,200	4,200 J	4,400 J	1,000 J	700 J	570 J	3,000 J	3,800 J	5,400 J	3,800 J	5,200 J	4,700 J	3,400 J	1,400 J	340 J	8,000 J	1,200 J
Manganese	2,500	910	330	8,300 J	490	85	510	1,100	880	570	1,300 J	930	330 J	190 J	160	290	750
Mercury	0.43	0.43	0.05	0.07	0.03	0.04	0.10	0.23	0.02	0.06	0.05	0.09	0.05	0.04	0.06	0.04	0.01
Nickel	1,600	650	610	59	21	10	1,300	800	7,000	1,100	1,100	1,000	790	810	22	890	10,000
Potassium	660	1,300 J	770 J	140 J	600 J	240 J	410 J	640 J	1,400 J	470 J	1,300 J	700 J	770 J	490 J	340 J	630 J	230 J
Selenium	15.00 U	6.90 J	4.40 J	4.70	1.80 J	2.60 J	8.10 J	5.70 J	4.80 K	5.80 J	5.50	4.00 J	5.70	4.70	1.70 J	3.50 J	3.60 J
Silver	58.00	14.00	48.00	140.00	0.39	0.48	9.50	21.00	43.00	13.00	34.00	18.00	8.90	3.90	1.80	77.00	29
Sodium	1,600	340 J	450 J	51	480 J	220 J	170 J	1,100 J	810 J	730 J	1,700	1,100 J	230	200	130 J	340 J	250 J
Thallium	8.40	0.31 UJ	0.32 UJ	0.11 J	0.24 J	0.07 J	0.12 J	0.11 J	0.09 J	0.10 J	0.05 J	0.11 J	0.32 U	0.05 J	0.10 J	0.32 UJ	1 J
Vanadium	34	11	12	21	29	12	10	18	14	15	20	17	12	12	27	10	6
Zinc	180,000	190,000	170,000	39,000	25,000	39,000	180,000	150,000	130,000	200,000	150,000	120,000	210,000	190,000	7,700	130,000	140,000

Notes:

mg/kg = milligrams per kilogram

U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limits.

J = The result is an estimated quantity. The associated material value is the approximate concentration of the analyte in the samples.

R = The data are unusable. The sample result is rejected due to serious deficiencies in meeting Quality control criteria. The analyte may or may not be present in the sample.

UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise

Source: Table III-3, RI Addendum (ENVIRON, 2005), sampled March 2005.

TABLE 6

Concentrations Detected in Onsite Surface Soil

Eagle Zinc Company Site, Hillsboro, Illinois

Sample ID	A1-26-S1	A1-3-S1	A1-3-S1-2	A2-13-S1	A2-3-S1	A2-3-S1D	NA-S1	NA-S2	NA-S2D	NA-S3	NA-S4
Depth	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"
Parameter (mg/kg)											
Aluminium	19,000 J	18,000 J	21,000 J	9,800 J	11,000 J	11,000	11,000	8,400	8,600	11,000	7,600
Antimony	18 UJ	5 J	2 UJ	18 UJ	19 UJ	18 UJ	19 UJ	19 UJ	21 UJ	19 UJ	20 UJ
Arsenic	12	21	5	2	11	7	7	4	5	4	3
Barium	190	150	110	150	160	150	160	120	93	150	84
Beryllium	1	1	1	1	1	1	1	0	1	1	0
Cadmium	7 J	8 J	5 J	6 J	8 J	7 J	3	6	8	3	2
Calcium	1,000	1,000	1,600	1,800	650	670	8,500	1,100	1,500	2,300	1,700
Chromium	21 J	22 J	23	13 J	15 J	15 J	14 J	11 J	13 J	13 J	10 J
Cobalt	13	12	6	3	18	8	8	4	7	4	3
Copper	130 J	180 J	12 J	27 J	8 J	12 J	20	67	170	19	10
Iron	27,000	25,000	19,000	8,100	16,000	12,000	14,000	9,000	10,000	11,000	7,300
Lead	500	1,100	24	26	30	29	87	120	230	40	31
Magnesium	2,200 J	2,700 J	2,500 J	990 J	1,400 J	1,400 J	1,300 J	1,000 J	1,100 J	1,200 J	920 J
Manganese	540	490	190	160	960	400	1,000 J	280 J	320 J	280 J	280 J
Mercury	0.042	0.028	0.041	0.034	0.020	0.023	0.020	0.031	0.050	0.019	0.015
Nickel	42 J	18 J	16 J	8 J	11 J	9 J	11	11	37	10	7
Potassium	1,300 J	1,400 J	670 J	840 J	900 J	940 J	910 J	730 J	750 J	870 J	810 J
Selenium	1 J	1 J	1 J	1 J	1	1 J	1 J	1 J	1 J	1 J	1 J
Silver	1	3	0 J	0	0 J	0 J	0	0	0	0	0 J
Sodium	53	41	73	98	70	66	36	47	58	37	33
Thallium	0	0	0 J	0 J	0	0	0	0	0 J	0	0 J
Vanadium	39	42	33	23	40	33	32	21	22	28	19
Zinc	4,800 J	2,700 J	93 J	770 J	480 J	710 J	1,600	5,100	7,700	1,500	950

Notes:

mg/kg = milligrams per kilogram.

U = The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limits.

J = The result is an estimated quantity. The associated material value is the approximate concentration of the analyte in the samples.

R = The data are unusable. The sample result is rejected due to serious deficiencies in meeting Quality control criteria. The analyte may or may not be present in the sample.

UJ = The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

Source: Table III-4, RI Addendum (ENVIRON, 2005), sampled March 2005.

TABLE 7
Residue Pile Data - IEPA Sampling, April 2005
Eagle Zinc Company Site, Hillsboro, Illinois

Sampling Location :	X301	X302	X303	X304	X305	X306	X307	X308	X309	X310	X311	X312	X313
Date Sampled :	4/25/05	4/25/05	4/25/05	4/25/05	4/25/05	4/25/05	4/25/05	4/25/05	4/26/05	4/26/05	4/26/05	4/26/05	4/26/05
Units:	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg	µg/Kg
Phenol	48 J	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	61 J	--	--	--	--	--	90 J	--	--	--	--	--	--
Fluoranthene	120 J	71 J	--	--	--	--	250 J	--	--	--	--	--	74 J
Pyrene	100 J	54 J	--	--	--	--	170 J	--	--	--	--	--	49 J
Benzo(a)anthracene	51 J	--	--	--	--	--	88 J	--	--	--	--	--	--
Chrysene	110 J	40 J	--	--	--	--	150 J	--	--	--	--	--	66 J
Benzo(b)fluoranthene	110 J	41 J	--	--	--	--	130 J	--	--	--	--	--	68 J
Benzo(k)fluoranthene	--	--	--	--	--	--	57 J	--	--	--	--	--	--
Benzo(a)pyrene	43 J	--	--	--	--	--	65 J	--	--	--	--	--	--
Benzo(g,h,i)perylene	55 J	--	--	--	--	--	50 J	--	--	--	--	--	--
Phenol	48 J	--	--	--	--	--	--	--	--	--	--	--	--
Phenanthrene	61 J	--	--	--	--	--	90 J	--	--	--	--	--	--
Fluoranthene	120 J	71 J	--	--	--	--	250 J	--	--	--	--	--	74 J
Pyrene	100 J	54 J	--	--	--	--	170 J	--	--	--	--	--	49 J
Benzo(a)anthracene	51 J	--	--	--	--	--	88 J	--	--	--	--	--	--
Chrysene	110 J	40 J	--	--	--	--	150 J	--	--	--	--	--	66 J
Benzo(b)fluoranthene	110 J	41 J	--	--	--	--	130 J	--	--	--	--	--	68 J
Benzo(k)fluoranthene	--	--	--	--	--	--	57 J	--	--	--	--	--	--
Benzo(a)pyrene	43 J	--	--	--	--	--	65 J	--	--	--	--	--	--
Benzo(g,h,i)perylene	55 J	--	--	--	--	--	50 J	--	--	--	--	--	--
Units :	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Aluminum	6,860	4,000	5,530	4,490	3,910	4,890	4,150	41,400	39,800	75,500	47,200	58,600	4,640
Antimony	13.3	13	28.6	355	13.1	6.7	320	429	665	628	621	608	109
Arsenic	11.1	7	158	124	37.1	26.7	141	48.1	34.2	61.1	52.6	53.4	175
Barium	356	58.9	1930	286	623	430	103	82	55.3	55.5	40.7	58.3	285
Beryllium	1.1	1.1	1.1	0.58	0.54	0.95	0.34 J	2.9	0.34 J	0.24 J	0.12 J	0.37 J	0.54 J
Cadmium	88.5	9	67.4	0.56 U	30.4	17.6	152	18.2	60.5	29	42	34.9	97.8
Calcium	8,160 J-	10,300 J-	2,100 J-	1,060 J-	1,250 J-	1,500 J-	11,300 J-	1,140 J-	723 J-	1,310 J-	751 J-	1,100 J-	7,630 J-
Chromium	16.2	8.6	20.6	18.7	15.3	10.1	169	902	278	1460	1620	1480	41.5
Cobalt	18.9	417	30.2	103	16.5	12.5	10.7	60.9	34.5	114	79.9	72.6	21
Copper	394	304	3,280	3,190	757	488	454	21,900	33,100	20,300	19,800	23,900	1,400
Iron	43,400	8,330	117,000	117,000	53,600	35,700	56,700	32,400	142,000	55,200	53,500	45,500	29,100
Lead	3,190	83.7	5,680	36,500	7,860	7,390	7,230	20,300	13,000	16,800	18,400	16,400	29,100
Magnesium	2,140 J-	4,720 J-	1,610 J-	492 J-	657 J-	446 J-	2,170 J-	1,340 J-	810 J-	1,440 J-	926 J-	1,620 J-	1,370 J-
Manganese	517	374	231	5,200	151	188	492	707	1,280	1,060	938	1,120	471
Mercury	2.3	0.058 J	0.061 J	1.6	0.078 J	0.11 U	0.2	0.081 J	0.14	0.11 J	0.052 U	0.12 U	0.15

TABLE 8
Surface Soil Data - IEPA Sampling, April 2005
Eagle Zinc Company Site, Hillsboro, Illinois

Sampling Location :	X104	X105	X106	X107	X108	X109	X110	X111	X112	X113	X114	X115	X116	X118	X119
Date Sampled :	4/27/05	4/27/05	4/27/05	4/27/05	4/27/05	4/27/05	4/27/05	4/27/05	4/27/05	4/26/05	4/27/05	4/27/05	4/27/05	4/27/05	4/26/05
Units :	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
Aluminum	8,110	4,770	8,230	5,210	10,400	6,850	6,040	5,880	9,170	7,070	7,330	5,200	7,510	6,720	4,870
Antimony	7.1 UJ	6.8 UJ	8.7 UJ	7.7 UJ	7.5 UJ	7.6 UJ	7 UJ	8.2 UJ	7.5 UJ	22.2	7.2 UJ	6.8 UJ	1.4 J	7.5 UJ	9.8 U
Arsenic	9.7 J	9.2 J	9.1 J	8.8 J	6.8 J	5.5 J	9.1 J	6.8 J	16.3 J	14.9	7.6 J	11.6 J	8.8 J	8.9 J	5.5 J
Barium	188	110	119	105	178	98.2	122	119	354	191	235	130	189	113	193
Beryllium	0.52 J	0.55 J	0.49 J	0.48 J	0.62	0.43 J	0.67	0.5 J	2.7	0.76	0.66	0.61	0.78	0.51 J	0.65 J
Cadmium	9.7	29.2	1.5	5.4	1.7	1.5	2.8	3.5	1.6	6	6.5	34.6	0.53 J	0.97	9.1
Calcium	50,500	2,500	6,320	2,060	7,200	1,620	62,900	3,570	13,000	14,400 J	12,300	2,270	30,300	9,720	6,190
Chromium	11.3	7.4	11.6	10.3	14.6	10.5	12.4	9.1	12.5	31.9	10	8.7	11.8	11.6	9.1
Cobalt	11.5	7.3	6.5 J	10.1	5 J	6.5	8.1	5.7 J	7.1	136	9	8	9.2	10.6	10.7
Copper	86.5	241	19.1	178	18.6	15.3	148	26.3	124	1710	139	219	13.3	10.8	57.8
Iron	16,600	19,100	14,700	15,900	13,200	10,300	25,800	11,700	50,500	107,000	15,600	22,800	14,000	14,000	10,300
Lead	48.4	408	53	155	50	45.8	267	164	417	401	287	489	27.1	34.4	273 J
Magnesium	1,990	1,030	1,980	908	1,800	1,270	2,440	1,360	2,480	3,210 J	1,600	1,050	1,770	1,460	926
Manganese	1,380	408	798	958	229	679	728	456	680	809	500	396	1,500	1,380	353 J
Mercury	0.087 J	0.093 J	0.12 J	0.13 U	0.11 J	0.064 J	0.078 J	0.085 J	0.13 U	0.11 J	0.12 U	0.072 J	0.071 J	0.06 J	0.51 J
Nickel	12.2	12.3	11.4	12.4	8.6	10.4	15.5	9.7	18.4	439	14.8	13.1	15.1	10.1	19.6
Potassium	1,080 J	390 J	880 J	479 J	1,210 J	787 J	740 J	908 J	1,340 J	1,250 J	769 J	403 J	785 J	557 J	464 UJ
Selenium	1.1 J	1.5 J	1 J	1.2 J	0.93 J	0.72 J	1.4 J	0.76 J	1.7 J	9.5 J	0.59 J	1.7 J	0.94 J	0.79 J	2 J
Silver	0.3 J	2.6	1.5 U	0.5 J	1.2 U	0.26 J	0.46 J	1.4 U	1.1 J	4.9	1.6	2.3	0.71 J	0.42 J	0.82 UJ
Sodium	95.7 J	185 J	75 J	84.1 J	102 J	59.4 J	328 J	72.4 J	1800	7320 J+	231 J	144 J	77.2 J	76.4 J	92.3 J
Thallium	2.9 U	2.8 U	3.6 U	3.2 U	3.1 U	3.2 U	2.9 U	3.4 U	3.1 U	3.2 R	3 U	2.8 U	3.3 U	3.1 U	4.1 U
Vanadium	26.2	20.1	24	23.1	26.2	17.5	23.1	16.9	45.1	29.9	22	25.5	24	25.7	15.9
Zinc	8,870	19,200	872	7,810	463	1,300	9,440	1,080	4,080	70,600	18,200	22,400	397	595	6,030
Cyanide	0.29 UJ	0.07 UJ	0.34 UJ	0.2 UJ	0.15 UJ	0.15 UJ	0.21 UJ	0.23 UJ	0.15 UJ	0.11 J	0.15 UJ	0.04 UJ	3.3 U	0.21 UJ	0.25 J

TABLE 9

Comparison of Pile Residue Concentrations with Residential Preliminary Remediation Goals (PRGs)

Eagle Zinc Company Site, Hillsboro, Illinois

Sample ID / Parameter (mg/kg)	Composite Sample	CPH-6	CPH-9	MP1-21	NP-13	NP-14	NP-15	NP-16	RCO-10	RCO-5	RRO-12D	RRO-12	RR1-1	RR1-2	RR1-3	RR1-4	RR2-11	Residential PRG
Aluminum	12,000	7,000	3,800	5,700	8,300	3,900	9,600	6,000	20,000	8,300	11,000	7,700	5,300	7,300	4,500	6,000	35,000	76,100
Antimony		8	16	[shaded]	17	16	[shaded]	4	[shaded]	7	17	[shaded]	16	16	16	16	[shaded]	31
Arsenic	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	0.39
Barium	220	210	150	870	290	210	110	130	350	230	420	170	160	130	480	150	130	5,400
Beryllium	1	1	1	1	1	1	1	1	2	3	2	2	1	1	1	1	2	200
Cadmium	22	10	6	[shaded]	23	32	19	15	24	21	10	7	6	9	35	5	7	37
Chromium	50	10	4	22	11	5	62	22	[shaded]	30	38	47	9	9	12	7	[shaded]	200
Cobalt	630	250	440	110	8	4	500	430	760	570	560	440	140	70	10	880	93	900
Copper	[shaded]	2,400	2,100	[shaded]	190	140	1,900	1,900	[shaded]	2,200	[shaded]	2,200	[shaded]	2,000	400	2,600	[shaded]	3,100
Iron	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	5,500	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	23,500
Lead	[shaded]	[shaded]	79	[shaded]	78	74	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	250	[shaded]	120	[shaded]	400
Manganese	[shaded]	910	330	[shaded]	480	65	510	1,100	880	570	1,300	930	330	190	160	290	750	1,800
Mercury	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23
Nickel	1,600	650	610	59	21	10	1,300	800	[shaded] 7,000	1,100	1,100	1,000	790	610	22	890	[shaded]	1,600
Selenium	15	7	4	5	2	3	8	6	5	6	6	4	6	5	2	4	4	400
Silver	58	14	48	140	0	0	10	21	43	13	34	18	9	4	2	77	29	400
Thallium	[shaded]	0.3	0.3	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.3	1.0	5
Vanadium	34	11	12	21	29	12	10	18	14	15	20	17	12	12	27	10	6	100
Zinc	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	7,700	[shaded]	23,500

Notes:

Residential PRGs are based on a 1 x 10^{-6} excess lifetime cancer risk or a noncancer hazard quotient of one.

Values shown as bolded and shaded were higher than the PRGs.

Note that a background concentration of arsenic in soil in Illinois is 11.3 mg/kg (ENVIRON, 2004).

TABLE 10

Comparison of Concentrations Detected in Onsite Surface Soil with Residential PRGs

Eagle Zinc Company Site, Hillsboro, Illinois

Sample ID	A1-28-S1	A1-3-S1	A1-3-S1-2	A2-13-S1	A2-3-S1	A2-3-S1D	NA-S1	NA-S2	NA-S2D	NA-S3	NA-S4	Residential
Depth	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	PRGs
Parameter (mg/kg)												
Aluminum	19,000	18,000	21,000	9,800	11,000	11,000	11,000	8,400	8,600	11,000	7,600	76,100
Antimony	18	5	2	18	19	18	19	19	21	19	20	31
Arsenic	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	0.43
Barium	190	150	110	150	160	150	160	120	93	150	84	5,400
Beryllium	1	1	1	1	1	1	1	0	1	1	0	200
Cadmium	7	8	5	6	8	7	3	6	8	3	2	37
Chromium	21	22	23	13	15	15	14	11	13	13	10	200
Cobalt	13	12	6	3	18	8	8	4	7	4	3	900
Copper	130	180	12	27	8	12	20	67	170	19	10	3,100
Iron	▓	▓	19,000	8,100	16,000	12,000	14,000	9,000	10,000	11,000	7,300	23,500
Lead	▓	▓	24	26	30	29	87	120	230	40	31	400
Manganese	540	490	190	160	960	400	1,000	260	320	260	280	1,800
Mercury	0.042	0.028	0.041	0.034	0.020	0.023	0.020	0.031	0.050	0.019	0.015	23
Nickel	42	18	16	8	11	9	11	11	37	10	7	1,600
Selenium	1.0	1.1	0.6	0.8	1.2	0.9	0.9	0.9	1.1	0.6	0.6	400
Silver	1.0	3.4	0.1	0.1	0.1	0.1	0.3	0.2	0.4	0.1	0.1	400
Thallium	0.4	0.3	0.2	0.2	0.4	0.4	0.2	0.2	0.2	0.2	0.1	5.2
Vanadium	39	42	33	23	40	33	32	21	22	28	19	100
Zinc	4,800	2,700	93	770	460	710	1,600	5,100	7,700	1,500	950	23,500

Notes:

Residential PRGs are based on a 1 x 10⁻⁶ excess lifetime cancer risk or a noncancer hazard quotient of one.

Values shown as bolded and shaded were higher than the PRGs

Note that a background concentration of arsenic in soil in Illinois is 11.3 mg/kg (ENVIRON, 2004).

TABLE 11
Comparison of Pile Residue Concentrations with Industrial PRGs
Eagle Zinc Company Site, Hillsboro, Illinois

Sample ID	Composite Sample	CPH-6	CPH-9	MP1-21	NP-13	NP-14	NP-15	NP-16	RCO-10	RCO-5	RRO-12D	RRO-12	RR1-1	RR1-2	RR1-3	RR1-4	RR2-11	Industrial PRG
Parameter (mg/kg)																		
Aluminum	12,000	7,000	3,800	5,700	8,300	3,900	9,600	6,000	20,000	8,300	11,000	7,700	5,300	7,300	4,500	6,000	35,000	100,000
Antimony		8	16	190	17	16	110	4	190	7	17	41	16	16	16	16	400	400
Arsenic	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	2
Barium	220	210	150	870	290	210	110	130	350	230	420	170	160	130	480	150	130	66,600
Beryllium	1	1	1	1	1	1	1	1	2	3	2	2	1	1	1	1	2	1,900
Cadmium	22	10	6	50	23	32	19	15	24	21	10	7	6	9	35	5	7	450
Chromium	50	10	4	22	11	5	62	22	220	30	38	47	9	9	12	7	290	400
Cobalt	630	250	440	110	8	4	500	430	780	570	580	440	140	70	10	880	93	1,900
Copper	3,700	2,400	2,100	3,800	190	140	1,900	1,900	24,000	2,200	3,400	2,200	3,400	2,000	400	2,800	34,000	40,900
Iron	82,000 [shaded]	[shaded]	47,000	[shaded]	24,000	5,500	31,000	36,000	60,000	25,000	73,000	48,000	75,000	60,000	88,000	72,000	77,000	100,000
Lead	[shaded]	800	79	[shaded]	76	74	[shaded]	550	[shaded]	530	520	[shaded]	450	250	[shaded]	120	[shaded]	800
Manganese	2,500	910	330	8,300	490	65	510	1,100	880	570	1,300	930	330	190	180	290	750	19,500
Mercury	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	300
Nickel	1,800	650	610	59	21	10	1,300	800	7,000	1,100	1,100	1,000	790	610	22	890	10,000	20,400
Selenium	15	7	4	5	2	3	8	6	5	6	6	4	8	5	2	4	4	5,100
Silver	58	14	48	140	0	0	10	21	43	13	34	18	9	4	2	77	29	5,100
Thallium	8.4	0.3	0.3	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.1	0.1	0.3	1.0	100
Vanadium	34	11	12	21	29	12	10	18	14	15	20	17	12	12	27	10	8	1,000
Zinc	[shaded]	[shaded]	[shaded]	39,000	25,000	39,000	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	[shaded]	7,700	[shaded]	100,000

Notes:
Industrial PRGs are based on a 1 x 10⁶ excess lifetime cancer risk or a noncancer hazard quotient of one.
Values shown as bolded and shaded were higher than the PRGs
Note that a background concentration of arsenic in soil in Illinois is 11.3 mg/kg (ENVIRON, 2004).

TABLE 12

Comparison of Concentrations Detected in Onsite Surface Soil with Industrial PRGs

Eagle Zinc Company Site, Hillsboro, Illinois

Sample ID:	A1-26-S1	A1-3-S1	A1-3-S1-2	A2-13-S1	A2-3-S1	A2-3-S1D	NA-S1	NA-S2	NA-S2D	NA-S3	NA-S4	Industrial
Depth:	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	0-6"	PRGs
Parameter (mg/kg)												
Aluminum	19,000	18,000	21,000	9,800	11,000	11,000	11,000	8,400	8,600	11,000	7,600	100,000
Antimony	18	5	2	18	19	18	19	19	21	19	20	400
Arsenic												1.6
Barium	190	150	110	150	160	150	160	120	93	150	84	66,600
Beryllium	1	1	1	1	1	1	1	0	1	1	0	1,900
Cadmium	7	8	5	6	8	7	3	6	8	3	2	500
Chromium	21	22	23	13	15	15	14	11	13	13	10	400
Cobalt	13	12	6	3	18	8	8	4	7	4	3	1,900
Copper	130	180	12	27	8	12	20	67	170	19	10	40,900
Iron	27,000	25,000	19,000	8,100	16,000	12,000	14,000	9,000	10,000	11,000	7,300	-100,000
Lead	500		24	26	30	29	87	120	230	40	31	800
Manganese	540	490	190	160	960	400	1,000	260	320	260	280	19,500
Mercury	0.042	0.028	0.041	0.034	0.020	0.023	0.020	0.031	0.050	0.019	0.015	300
Nickel	42	18	16	8	11	9	11	11	37	10	7	20,400
Selenium	1.0	1.1	0.6	0.8	1.2	0.9	0.9	0.9	1.1	0.6	0.6	5,100
Silver	1.0	3.4	0.1	0.1	0.1	0.1	0.3	0.2	0.4	0.1	0.1	5,100
Thallium	0.4	0.3	0.2	0.2	0.4	0.4	0.2	0.2	0.2	0.2	0.1	100
Vanadium	39	42	33	23	40	33	32	21	22	28	19	1,000
Zinc	4,800	2,700	93	770	460	710	1,600	5,100	7,700	1,500	950	100,000

Notes:

Industrial PRGs are based on a 1 x 10^{-6} excess lifetime cancer risk or a noncancer hazard quotient of one.

Values shown as bolded and shaded were higher than the PRGs.

Note that a background concentration of arsenic in soil in Illinois is 11.3 mg/kg (ENVIRON, 2004).

TABLE 13
Comparison of Pile Residue Concentrations with Construction/Excavation PRGs
Eagle Zinc Company Site, Hillsboro, Illinois

Sample ID	COMPOSITE SAMPLE	CPH-3	CPH-3	MPH-21	MPH-13	MP-14	MP-13	MP-16	RCD-18	RCD-5	RRD-12D	RRD-12	RRR-1	RRR-2	RRR-3	RRR-4	RRR-11	Construction PRG
Parameter (mg/kg)																		
Lead		800	79	79	78	74	1,200	650		530	520	810	460	250		120		1,204

Notes:
Values shown as bolded and shaded were higher than the PRG.

TABLE 14

Comparison of Pile Residue Concentrations with Recreational PRGs.

Eagle Zinc Company Site, Hillsboro, Illinois

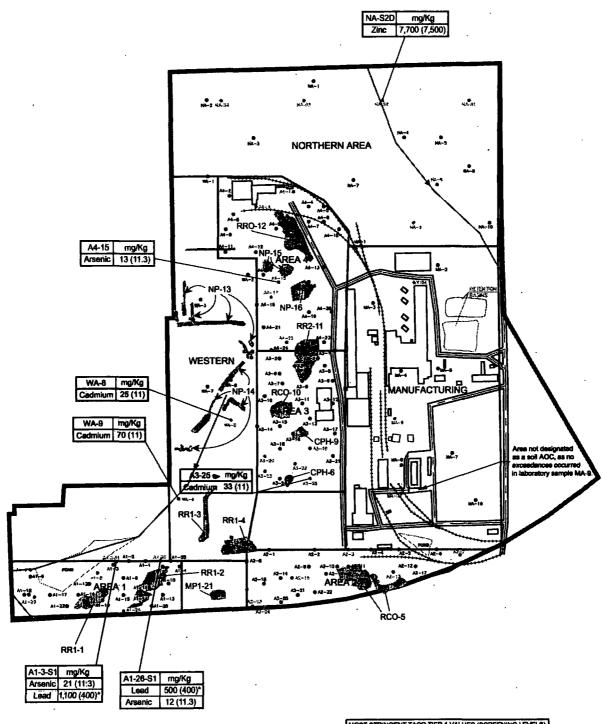| Sample ID	COMPOSITE SAMPLE	CPH-5	CPH-9	MP1-21	NP-13	NP-14	NP-15	NP-16	RCO-10	RCO-5	RRO-12D	RRO-12	RR1-1	RR1-2	RR1-3	RR1-4	RR2-11	Recreational PRG
Parameter (mg/kg)																		
Lead	▓▓▓▓▓	800	79 ▓▓▓	78	74 ▓▓	550 ▓▓	530	520	810	450	250 ▓▓	120 ▓▓	1,139

Notes:

Values shown as bolded and shaded were higher than the PRG

TABLE 15
Universal Soil Loss Equation Results for Individual Piles
Eagle Zinc Company Site, Hillsboro, Illinois

$$A = RKLSCP$$

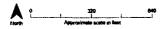| Symbol	Value	Description	Units	Notes
R	210	Rainfall and runoff erosivity index for a given location	tons/acre/unit area	Wischmeier and Smith, 1978
K		Soil erodibility factor	unit area/year	
L	measured	Slope length factor	unitless	ENVIRON, 2005
S	measured	Slope steepness factor	unitless	ENVIRON, 2005
LS	computed	Topographic factor	unitless	Wischmeier and Smith, 1978
C		Cover and management factor	unitless	Wischmeier and Smith, 1978
P	1.0E+00	Conservation or support practice factor	unitless	Wischmeier and Smith, 1978
A	calculated	Average annual soil loss	tons/acre/year	

Pile	R	K	L	S	LS	C	P	A	Area (ft2)	Area (acres)	Average Annual Soil Loss (tons/year)
CPH-6	210	0.1	19.19	125	20	0.45	1	189	1,862	0.04	8.08
CPH-9	210	0.1	23.1	124	20	0.45	1	189	3,228	0.07	14.01
NP-15	210	0.1	21.85	66	15	0.45	1	141.75	5,942	0.14	19.34
NP-16	210	0.1	32.35	122	20	0.45	1	189	8,922	0.20	38.71
RCO-10	210	0.1	28.38	100	20	0.45	1	189	8,192	0.19	35.54
RR1-3	210	0.1	21.34	40	5.8	0.45	1	54.81	7,490	0.17	9.42
RR2-11	210	0.1	40.68	109	20	0.45	1	189	20,689	0.47	89.77
RRO-12	210	0.1	31.63	54	9.5	0.45	1	89.775	20,922	0.48	43.12

Figures

NA-S2D	mg/Kg
Zinc	7,700 (7,500)

NORTHERN AREA

RRO-12

NP-15 AREA 4

A4-15	mg/Kg
Arsenic	13 (11.3)

NP-13

NP-16

RR2-11

WESTERN

WA-8	mg/Kg
Cadmium	25 (11)

NP-14

RCO-10

WA-9	mg/Kg
Cadmium	70 (11)

AREA 3

CPH-9

A3-25	mg/Kg
Cadmium	33 (11)

CPH-6

RR1-3

RR1-4

MANUFACTURING

RETENTION BASINS

Area not designated as a soil AOC, as no exceedances occurred in laboratory sample MA-9.

AREA 1

RR1-2

MP1-21

AREA 2

RCO-5

RR1-1

A1-3-S1	mg/Kg
Arsenic	21 (11.3)
Lead	1,100 (400)*

A1-26-S1	mg/Kg
Lead	500 (400)*
Arsenic	12 (11.3)

LEGEND

• Soil Boring - sample not sent to lab

• Soil Boring - sample sent to lab

( ) Most Stringent Taco Tier I Value (Screening Value)

▓ Residue Piles

←— Storm Water Drainageway

* Lead screening level based on USEPA Region III RBC.

Adapted from Environ.

North   0   320   640
Approximate scale in feet

MOST STRINGENT TACO TIER 1 VALUES (SCREENING LEVELS)			
	Industrial I/I	Construction I/I	Soils→GWI
Arsenic	11.3	61	29
Cadmium	2,000	200	11
Zinc	610,000	61,000	7,500

FIGURE 1
Surface Soil Sampling Results Above
Screening Levels and Residue Piles
Eagle Zinc, Hillsboro, Illinois

CH2MHILL

Figure 4
Eagle Zinc Company
Sample Location Map

Legend
○ Soil
● Sediment
● Waste
— Site Boundary

0 0.05 0.1   0.2   0.3   0.4
                                    Miles

Attachment 2
Development of PRGs for Lead in Soil

ATTACHMENT 2
Trespasser/Recreational Use PRG
Eagle Zinc Company Site
Hillsboro, IL

Calculations of Preliminary Remediation Goals (PRGs)
U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/03

$PbB_{fetal, 0.95}$	X	X	95th percentile PbB in fetus	ug/dL	10	10	10	10
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	–	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	–	2.1	2.3	2.1	2.3
PbB_0	X	X	Baseline PbB	ug/dL	1.5	1.7	1.5	1.7
IR_s	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.100	0.100	–	–
IR_{s+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	–	–	0.100	0.100
W_s		X	Weighting factor; fraction of IR_{s+D} ingested as outdoor soil	–	–	–	1.0	1.0
K_{SD}		X	Mass fraction of soil in dust	–	–	–	0.7	0.7
$AF_{s, D}$	X	X	Absorption fraction (same for soil and dust)	–	0.12	0.12	0.12	0.12
$EF_{s, D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	75	75	75	75
$AT_{s, D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PRG			Preliminary Remediation Goal	ppm	1,603	1,139	1,603	1,139

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_s, K_{SD}).

When $IR_s = IR_{s+D}$ and $W_s = 1.0$, the equations yield the same PRG.

*Equation 1, based on Eq. 4 in USEPA (1996).

$$PRG = \frac{([PbB_{95}fetal/(R*(GSD_i^{1.645})])-PbB_0)*AT_{s,D}}{BKSF*(IR_{s+D}*AF_{s,D}*EF_{s,D})}$$

**Equation 2, alternate approach based on Eq. 4 and Eq. A-19 in USEPA (1996).

$$PRG = \frac{([PbB_{fetal,0.95}/(R*(GSD_i^{1.645})])-PbB_0)*AT_{s,D}}{BKSF*([(IR_{s+D})*AF_s*EF_s*W_s]+[K_{SD}*(IR_{s+D})*(1-W_s)*AF_D*EF_D])}$$

Calculations of Preliminary Remediation Goals (PRGs)

Calculations of Preliminary Remediation Goals (PRGs)
U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee

Version date 05/19/03

$PbB_{fetal, 0.95}$	X	X	95th percentile PbB in fetus	ug/dL	10	10	10	10
$R_{fetal/maternal}$	X	X	Fetal/maternal PbB ratio	--	0.9	0.9	0.9	0.9
BKSF	X	X	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4	0.4	0.4
GSD_i	X	X	Geometric standard deviation PbB	--	2.1	2.3	2.1	2.3
PbB_0	X	X	Baseline PbB	ug/dL	1.5	1.7	1.5	1.7
IR_s	X		Soil ingestion rate (including soil-derived indoor dust)	g/day	0.330	0.330	--	--
IR_{s+D}		X	Total ingestion rate of outdoor soil and indoor dust	g/day	--	--	0.330	0.330
W_s		X	Weighting factor; fraction of IR_{s+D} ingested as outdoor soil	--	--	--	1.0	1.0
K_{SD}		X	Mass fraction of soil in dust	--	--	--	0.7	0.7
$AF_{s, D}$	X	X	Absorption fraction (same for soil and dust)	--	0.12	0.12	0.12	0.12
$EF_{s, D}$	X	X	Exposure frequency (same for soil and dust)	days/yr	20	20	20	20
$AT_{s, D}$	X	X	Averaging time (same for soil and dust)	days/yr	365	365	365	365
PRG			Preliminary Remediation Goal	ppm	2,049	1,294	2,049	1,294

[1] Equation 1 does not apportion exposure between soil and dust ingestion (excludes W_s, K_{SD}).
When $IR_s = IR_{s+D}$ and $W_s = 1.0$, the equations yield the same PRG.

*Equation 1, based on Eq. 4 in USEPA (1996).

$$PRG = \frac{([PbB_{95}fetal/(R*(GSD_i^{1.645})])-PbB_0)*AT_{S,D}}{BKSF*(IR_{S+D}*AF_{S,D}*EF_{S,D})}$$

**Equation 2, alternate approach based on Eq. 4 and Eq. A-19 in USEPA (1996).

$$PRG = \frac{([PbB_{fetal,0.95}/(R*(GSD_i^{1.645})])-PbB_0)*AT_{S,D}}{BKSF*(((IR_{S+D})*AF_S*EF_S*W_S]+[K_{SD}*(IR_{S+D})*(1-W_S)*AF_D*EF_D])}$$

Source: U.S. EPA (1996). Recommendations of the Technical Review Workgroup for Lead
for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil

Attachment 3
Evaluation of Construction Dust Emissions

MP1-21 Construction Impacts

Parameter	Symbol	Value	Notes
Emission Flux (tons/acre-month)		1.2	
Conversion factors			
lbs/ton		2000	
g/lb		454	
days/month		30	
seconds/day		86400	
m^2/acre		4047	
Emissions flux (g/m^2-s)	F	1.04E-04	

Calculate Chemical-Specific Emission Rates

Parameter	Measured Concentration (mg/kg)	Conversion Factor (kg/mg)	Emission Rate (g/m^2-s)	Notes
Aluminum	5700	0.000001	5.92E-07	
Antimony	190	0.000001	1.97E-08	
Arsenic	200	0.000001	2.08E-08	
Barium	870	0.000001	9.04E-08	
Beryllium	0.8	0.000001	8.73E-11	
Cadmium	50	0.000001	5.19E-09	
Chromium	22	0.000001	2.29E-09	
Cobalt	110	0.000001	1.14E-08	
Copper	3600	0.000001	3.74E-07	
Iron	110000	0.000001	1.14E-05	
Lead	31000	0.000001	3.22E-06	
Manganese	8300	0.000001	8.62E-07	
Mercury	0.07	0.000001	6.75E-12	
Nickel	59	0.000001	6.13E-09	
Selenium	5	0.000001	4.88E-10	
Silver	140	0.000001	1.45E-08	
Thallium	0.1	0.000001	1.14E-11	
Vanadium	21	0.000001	2.18E-09	
Zinc	39000	0.000001	4.05E-06	

RR2-11 Construction Impacts

Parameter	Symbol	Value
Emission Flux (tons/acre-month)		1.2
Conversion factors		
lbs/ton		2000
g/lb		454
days/month		30
seconds/day		86400
m^2/acre		4047
Emissions flux (g/m^2-s)	F	1.04E-04

Calculate Chemical-Specific Emission Rates

Parameter	Measured Concentration (mg/kg)	Conversion Factor (kg/mg)	Emission Rate (g/m^2-s)
Aluminum	35,000	0.000001	3.64E-06
Antimony	400	0.000001	4.15E-08
Arsenic	21	0.000001	2.18E-09
Barium	130	0.000001	1.35E-08
Beryllium	1.5	0.000001	1.56E-10
Cadmium	7	0.000001	7.48E-10
Chromium	290	0.000001	3.01E-08
Cobalt	93	0.000001	9.66E-09
Copper	34,000	0.000001	3.53E-06
Iron	77,000	0.000001	8.00E-06
Lead	7,700	0.000001	8.00E-07
Manganese	750	0.000001	7.79E-08
Mercury	0.01	0.000001	1.25E-12
Nickel	10,000	0.000001	1.04E-06
Selenium	4	0.000001	3.74E-10
Silver	29	0.000001	3.01E-09
Thallium	1.0	0.000001	1.04E-10
Vanadium	6	0.000001	5.92E-10
Zinc	140,000	0.000001	1.45E-05